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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/893,035	06/27/2001	Hag-ju Cho	5649-874	3421

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EXAMINER
KIELIN, ERIK J

ART UNIT	PAPER NUMBER
2813	5

DATE MAILED: 04/01/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/893,035	CHO, HAG-JU	
	Examiner	Art Unit	
	Erik Kielin	2813	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *08 February 2002* .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-13* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-13* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☒ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *27 June 2001* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

Election/Restrictions

1. Applicant's election without traverse of Group I, claims 1-13 in Paper No. 4 is acknowledged. Claims 14-24 are withdrawn from further consideration because Applicant has cancelled these non-elected claims.

Specification

2. The abstract of the disclosure is objected to because it has not been provided on a separate sheet of paper. Instead, it has been provided on a sheet of paper including the title. Correction is required. See MPEP § 608.01(b).

Claim Rejections - 35 USC § 102

3. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (e) the invention was described in-
> (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effect under this subsection of a national application published under section 122(b) only if the international application designating the United States was published under Article 21(2)(a) of such treaty in the English language; or
> (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that a patent shall not be deemed filed in the United States for the purposes of this subsection based on the filing of an international application filed under the treaty defined in section 351(a).

4. Claims 1, 2, 5, 9, and 11-13 are rejected under 35 U.S.C. 102(e) as being anticipated by Patent Application US 2001/0024387 A1 (**Raaijmakers** et al.).

Regarding claim 1, **Raaijmakers** discloses a method of manufacturing an integrated circuit device that comprises an insulation layer comprising

forming the insulation layer (called "native oxide" or OH terminated surface) by exposing the surface of the bottom electrode of a capacitor to the "clean room environment" (paragraph [0054]);

exposing the insulation layer to a metal precursor, which may be at least any of those recited in paragraph [0074], each of which is reactive with oxygen --by Applicant's admission-- to form a first metal oxide layer 302 on the insulation layer. (See paragraphs [0054]-[0056], and [0090].)

Regarding claim 2, the method of deposition of the metal oxide is by atomic layer deposition (ALD) wherein the integrated circuit is exposed to a metal precursor pulse for various exemplary times of 0.1 to 1 seconds at exemplary flow rates of 20 to 40 sccm and then exposed to pulses of carrier gas at an exemplary flow rate of 400 sccm for periods of 0.2 to 6 seconds to remove the un-reacted metal precursor. (See Tables I-VI and paragraphs [0071] to [0086].)

Regarding claim 5, the metal precursor pulse is provided along with a N_2 carrier gas. (See Tables I-VI.)

Regarding claim 9, see paragraph [0074] and [0087].

Regarding claim 11, the insulation layer comprises a capacitor dielectric 24 (Fig. 1A) or 302 (Fig. 7).

Regarding claim 12, because the "native oxide" is on silicon, the insulation layer is SiO_2.

Regarding claim 13, because the layers are built up layer-by-layer wherein each 3 cycles forms a monolayer (paragraph [0077]) and because at least 10-20 cycles is performed (paragraph [0083] or 20 to 25 cycles (paragraph [0099]) or 30 to 80 cycles (paragraph [0108]), each

additional monolayer layer encapsulates the layer before it. Accordingly, the first metal oxide layer and the insulation layer are necessarily encapsulated by a second metal oxide layer.

5. Claims 1, 2, 9, and 11-13 are rejected under 35 U.S.C. 102(e) as being unpatentable over Patent Application US 2001/0006835 A1 (**Kim** et al.).

Regarding claims 1, 9, 11, and 12, **Kim** discloses a method of treating an integrated circuit device comprising,

exposing at least a portion of an insulating film containing oxygen 122A (Figs. 1A-1B) to a metal precursor that is reactive with oxygen (modified trimethyl aluminum, as further limited by instant claim 9) so as to from a first metal oxide layer 140 (Fig. 1C) on the exposed portion of the insulation layer, wherein the insulation layer may be formed from aluminum oxide (Al_2O_3) (as further limited by instant claim 12) and wherein the insulation layer 122A may be a capacitor dielectric (as further limited by instant claim 11); and then providing an "oxygen treatment" for the metal-oxide-coated integrated circuit in using N_2O or ozone atmosphere so as to remove carbon contamination and to densify the Al_2O_3 (paragraph [0018]). (See also paragraphs [0014]-[0021].)

Regarding claim 2, the Al_2O_3 is deposited by ALD, wherein the integrated circuit is exposed to a metal precursor pulse for various exemplary times of 0.1 to 3 seconds using flow controllers. (See paragraphs [0016]; Fig. 2.)

The same reasoning for rejecting claim 13 regarding the encapsulation of the first metal oxide layer by a second metal oxide layer, is applied here because it is the intrinsic result of using ALD as the method of deposition.

6. Applicant cannot rely upon the foreign priority papers to overcome this rejection because a translation of said papers has not been made of record in accordance with 37 CFR 1.55. See MPEP § 201.15.

Claim Rejections - 35 USC § 103

7. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

8. Claims 3, 4, and 10 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Raaijmakers**.

The prior art of **Raaijmakers**, as explained above, discloses each of the claimed features except for specifically indicating Applicant's exact flow rates, pulse times for the metal precursors and purge gas (instant claims 3 and 4). As noted above, the disclosed pulse times in **Raaijmakers** for both the metal precursor and the inert purge gas falls within Applicant's claimed range of 0.1-2 seconds and 0.1 to 10 seconds, respectively. Also the exact pressure and temperature ranges are not taught (instant claim 10). **Raaijmakers** does however teach temperatures ranging from 150-500 °C depending upon the metal precursor, which significantly overlaps the presently claimed 100-400 °C, and pressures ranging from 1 to 10 Torr which overlaps the presently claimed 0.1 to 1 Torr.

Although the deposition parameters are not as exactly claimed by Applicant, **Raaijmakers** states

> "Note that the parameters in the tables below are exemplary only. Each process phase is desirably arranged to saturate the bottom electrode surface. ... In view of the disclosure herein, the skilled artisan can readily modify, substitute or otherwise alter deposition conditions for different reaction chambers and for different selected conditions to achieve saturated, self-terminating phases at acceptable deposition rates." (See paragraph [0085].)

In light of the forgoing, it would be wholly obvious for one of ordinary skill in the art, at the time of the invention, to use the claimed deposition parameters in order to achieve the saturation of the surface of the exposed dielectric in order to achieve acceptable deposition rates, as taught by **Raaijmakers** for a given reaction chamber. One of ordinary skill would be further motivated to optimize the conditions of deposition for a specific metal oxide being formed depending upon the amount of exposed surface being coated and upon the reaction apparatus being used, as suggested in **Raaijmakers**. (See MPEP 2144.05.)

9. Claim 6 is rejected under 35 U.S.C. 103(a) as being unpatentable over **Raaijmakers** in view of Patent Application US 2001/0041250 A1 (**Werkhoven** et al.).

The prior art of **Raaijmakers**, as explained above, discloses each of the claimed features except for indicating that the carrier gas s argon.

Werkhoven teaches a very similar ALD method for treating integrated circuit devices wherein the carrier gas may be, inter alia, N_2 or Ar. (See paragraph [0061].)

It would be obvious for one of ordinary skill in the art, at the time of the invention, to use argon as a matter of design choice because it would appear that argon would work just as well as nitrogen being that each is inert in the process and because, as taught by **Werkhoven**, Ar is a common carrier gas for ALD.

10. Claims 3 and 4 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Kim** in view of **Raaijmakers.**

Regarding claims 3 and 4, **Kim** teaches a first exposure to a metal precursor followed by purging with nitrogen wherein each pulse is from 0.1-3 seconds which overlaps the instantly claimed pulse time ranges. **Kim** also teaches that the flows are regulated using a flow controller, so that some flow rate must be used, although the specific amount is not indicated.

Raaijmakers teaches a very similar method for ALD deposition of aluminum oxide and uses flow rates near those of the instant invention and, as noted above, indicates that the flow rates may be varied according to the desired needs. It would be obvious for one of ordinary skill in the art, at the time of the invention, to optimize the flow rate so as to saturate the reactive surface sites of the insulation layer for the reasons indicated above. (See MPEP 2144.05.)

11. Claims 7 and 8 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Kim** in view of US 6,335,240 B1 (Kim et al.; **Kim 2**, hereafter).

The prior art of **Kim**, as explained above, discloses each of the claimed features except for indicating the conditions of the disclosed oxygen treatment of the metal oxide Al_2O_3 film.

Kim 2 teaches annealing conditions for ALD deposited Al_2O_3 films using O_2 at a temperature of 150-900 °C with exemplary embodiments at 450 °C, which falls within Applicant's claimed range of 400-600 °C. (See **Kim 2**, Abstract; col. 8, Table 3).

It would be obvious for one of ordinary skill in the art, at the time of the invention, to use the densification treatment of the aluminum oxide provided in **Kim 2** in the method of **Kim**

because **Kim** did not specify conditions and the conditions in **Kim 2** are specifically for ALD formed Al_2O_3 in order to densify the film which is desired in **Kim**.

Although the time is not as exactly claimed in claim 8, the choice would be a matter of routine optimization with a single variable. One would be motivated to find the time required to densify the thin film in **Kim** for the specific purpose therein. Inasmuch as both **Kim** and the instant invention deposit the Al_2O_3 layer over the insulating layer of a capacitor as a hydrogen diffusion barrier, the layers serve the same purpose, so one of ordinary skill would be motivated to densify the Al_2O_3 for the period of time required to optimize the densification for the required purpose in **Kim.** Furthermore, because **Kim** is not limited to some period of time or temperature at which the Al_2O_3 layer is treated for the purposes indicated therein, one of ordinary skill would be motivated to optimize the process and thereby determine the required time and temperature ranges. (See MPEP 2144.05.)

12. Claim 10 is rejected under 35 U.S.C. 103(a) as being unpatentable over **Kim**.

The prior art of **Kim**, as explained above, discloses each of the claimed features except for indicating the pressure and temperature range (claim 10) for the deposition of the metal oxide. Kim does, however, disclose a reaction temperature of 200 - 450 °C, which overlaps the claimed range of 100 - 400 °C, and a pressure range of 0.05 - 0.3 Torr, which overlaps the claimed range of 0.1 to 1 Torr. Although these ranges are not exactly as claimed, it would be obvious to optimize the range for depositing a given metal oxide layer under given conditions depending upon the total exposed surface area of the insulation layer being treated and

depending upon the reaction chamber. One of ordinary skill would be motivated to optimize the conditions for the reason indicated above. (See MPEP 2144.05.)

Conclusion

13. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

US 6,200,893 B1 (**Sneh**) teaches that in ALD, the surface **must** be reactive with the precursor and that such surface is active oxygen, typically as hydroxyl groups. (See paragraph bridging cols. 1-2 col. 8, line 64 to col. 9, line 39.)

US 6,203,613 B1 (**Gates** et al.) discloses a method of treating an oxygen-containing insulation layer with a metal precursor reactive with oxygen using ALD to form single or plural layers of metal oxide. (See cols. 7-10.)

US 6,124,158 (**Dautartas** et al.) teaches that an ozone treatment after every 1-3 cycles during ALD of Al_2O_3 to removed carbon contamination. (See cols. 5-6.)

The article, **Kukli** et al. "In situ study of atomic layer epitaxy growth of tantalum oxide thin films from $Ta(OC_2H_5)_5$ and H_2O" Applied Surface Science 112 (1997) pp. 236-242 teaches the mechanism of deposition of tantalum oxide and shows that it reacts with active surface oxygen. (See Abstract and section entitled "Growth mechanism" p. 239.)

The article **Haukka** et al. "Growth mechanisms of mixed oxides on alumina" Applied Surface Science 112 (1997) pp. 23-29 teaches the mechanism of deposition of mixed oxides on alumina and shows that it reacts with active surface oxygen of alumina. (See Abstract and p. 26, right-hand column.)

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Erik Kielin whose telephone number is 703-306-5980. The examiner can normally be reached on 9:00 - 19:30 on Monday through Thursday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri can be reached at 703-306-2417. The fax phone numbers for the organization where this application or proceeding is assigned are 703-308-7722 for regular communications and 703-308-7722 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.

Erik Kielin
March 21, 2002